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US Army Corps of Engineers
Detroit District

Great Lakes Update

Ice Cover Impacts on the Great Lakes

Ice cover on the Great Lakes is highly variable year-to-year and exceedingly important to both water quantity and quality aspects of the lakes. Studies are underway on the climatologic variability of ice cover on the Great Lakes and correlations with lake level highs and lows. Without ice cover, evaporation can occur and lower water levels on the Great Lakes.

Many of the main rivers in the Great Lakes also have ice control measures to limit damage and keep these waterways ice-free. Some of these methods include ice booms and ice breaking.

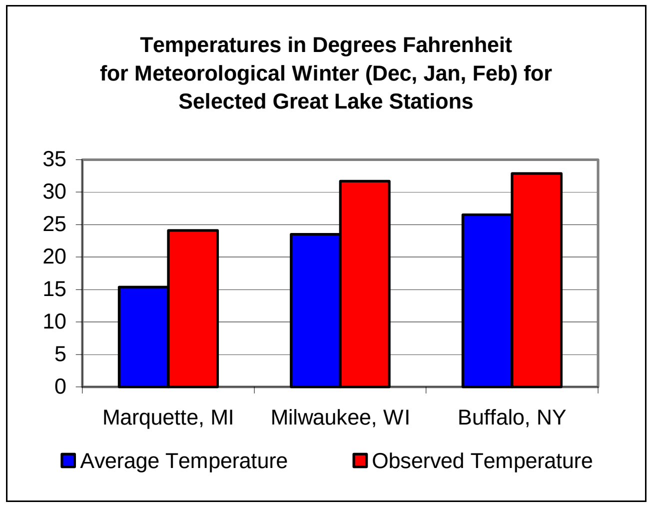
Ice cover on the Great Lakes is highly dynamic, which challenges ice researchers and resource managers. New projects are underway to improve the understanding of the processes involved with ice formation, break-up and control.

Recent Ice Conditions

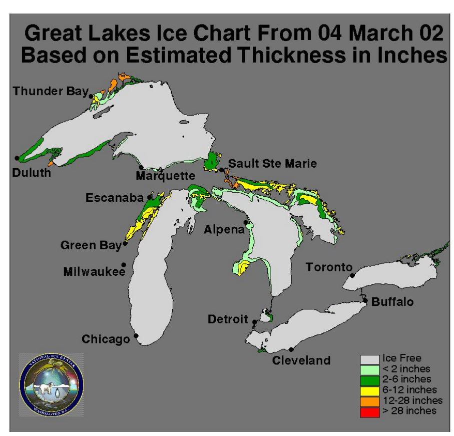
Ice cover this winter season was severely limited on all of the Great Lakes. An unseasonably mild winter throughout the Great Lakes basin is the cause of this phenomenon.

The following graph shows that air temperatures over much of the Great Lakes for the meteorological winter (December through February) were more than 6 degrees Fahrenheit warmer than average.

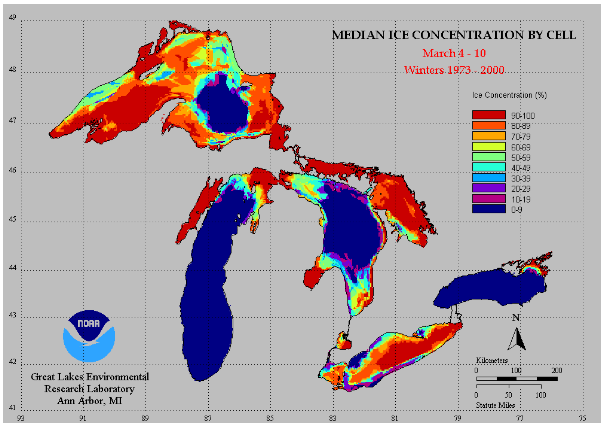
Lakes St. Clair and Erie usually freeze over completely during most of the winter. This winter both lakes had very inconsistent coverage from one day to the next. Lake St Clair froze over with light ice a few times but never had complete and continuous coverage for any sustained period of time.



During the winter of 2001-02 ice formed only on protected bays and shallow inlets. The map below shows the extent of ice for early March when ice conditions are typically at their maximum.



Ice Conditions on March 4, 2002 (NATICE)



Median Ice Cover for March 4-10 (GLERL)

The map above is provided by the Great Lakes Environmental Research Laboratory (GLERL) of the National Oceanic and Atmospheric Administration (NOAA). This map shows the average ice cover for early March over the Great Lakes, which is the time of the year when ice cover is typically at its maximum extent.

Previous Winter Conditions

Below average ice conditions have persisted over the entire Great Lakes for most of the last five years. There are several theories that exist that try to explain these consistent below average ice conditions. These include "global warming" caused by increased carbon dioxide (CO_2) globally and Pacific Ocean "El Nino" events. There is speculation that this warm period may be similar to other multi-year periods that have occurred in the past.

Mr. Raymond Assel, a meteorologist with the GLERL in Ann Arbor, MI has been studying Great Lakes ice conditions for nearly 30 years. He is recognized as the leading expert on ice climatology in the region. One of Mr. Assel's current research projects is to assess whether similar warm trends occurred in the past and whether this warm trend could persist into the near future.

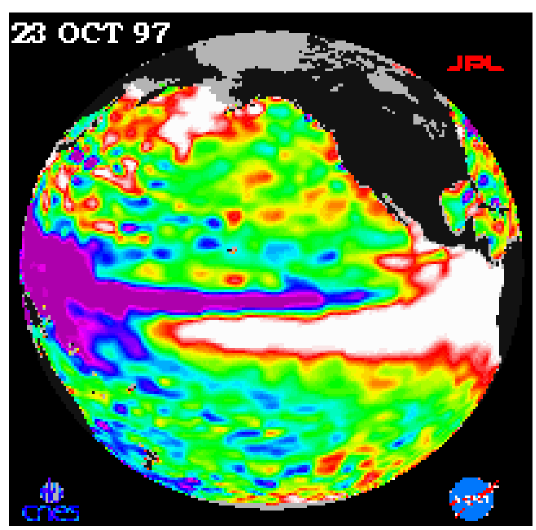
Mr. Assel was interviewed recently and stated: "Whether it's unique or not will take a little more time to tell. If we get another two or three or four (winters) like this, then you expect a new ice cover regime for the Great Lakes. We only have about forty years of data and some cycles last much longer than forty years."

Mr. Assel's research has been used by other scientists looking at global warming as a possible factor in the reduction of ice cover on the Great Lakes. Global warming is normally attributed to an increase in carbon dioxide and other gases in the atmosphere. Mr. Joel Smith published an article outlining these prospects entitled "The Potential Impacts of Climate Change on the Great Lakes" (Bulletin of the American Meteorological Society, 1991).

If significant global warming occurs, Mr. Assel has indicated that ice cover could be reduced slightly between 1981 and 2009 and significantly more thereafter. Some scenarios that could arise if major global warming occurs are the virtual disappearance of ice on central and eastern Lake Erie and a reduction in the time that Lake Superior has ice cover. Typically Superior has ice cover for four months out of the year, but this could be reduced to only one to two and one-half months with a significant increase in atmospheric CO_2.

El Nino Effects

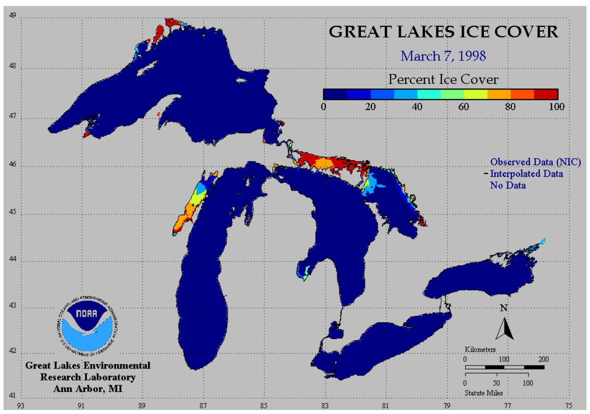
Recent research has shown that Great Lakes ice cover is affected by large-scale ocean and atmospheric patterns a long distance away. The best example of this is the El Nino Southern Oscillation or simply El Nino. The term "El Nino" is used for a warming of the tropical Pacific Ocean. It is most noticed off the coast of Peru in South America.



Sea Surface Temperatures in the Pacific Ocean (JPL, Cal Tech , NASA)

The previous satellite picture is from October of 1997. White areas in the image show sea surface temperatures up to ten degrees above normal.

Studies have shown that El Nino conditions are a precursor to above average winter temperatures in the Great Lakes region and below average ice cover on the Great Lakes. This is most evident in the winter of 1997-1998, which followed an extremely strong 1997 El Nino period. Ice cover following this El Nino event was near record lows as evidenced by the map below.



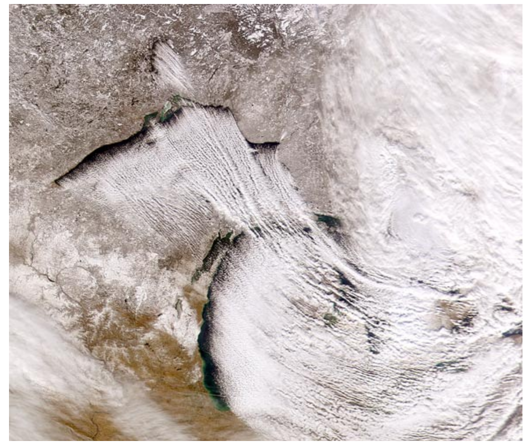
1998 Ice Conditions after strong El Nino in 1997 (GLERL)

Ice Cover and Evaporation

The role of ice cover on the water levels of the Great Lakes is currently under investigation as well. Ice usually acts as barrier to evaporation. With little or no ice, the Great Lakes are susceptible to significant evaporation. Heavy evaporation causes large cloud formations and lake-effect snows on the leeward sides of each of the Great Lakes.

The evaporation process, for the most part, is an invisible but very significant factor in the loss of water from the Great Lakes. During prime evaporation periods, the Lakes may lose 1-2 inches of surface water per week due to this phenomenon.

Maximum evaporation occurs when the Great Lakes are much warmer than the air moving across them, particularly in the early fall before ice forms on the lakes. The evaporation results in many more cloudy days in Michigan than occur in Wisconsin, and is responsible for the "lake effect" snows that are common to the region.



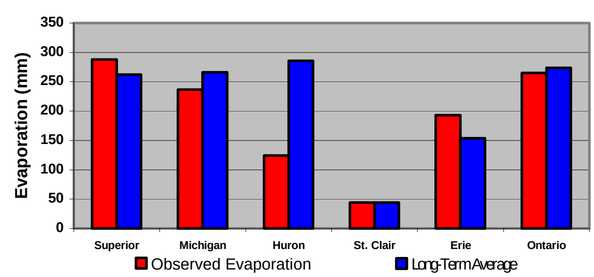
December 2000 Satellite Image
Provided by the SeaWiFS Project
NASA/Goddard Flight Center and ORBIMAGE

This satellite image shows a major lake-effect snow event on December 5, 2000. Strong and cold northwesterly winds whipped across the warmer lakes causing 5 inches of snow to fall on parts of Michigan's Upper Peninsula and nearly 2 feet of snow to fall in the Buffalo, New York region.

This winter warmer than average lake surface temperatures caused dramatic lake-effect snowfall across the region. Areas around Buffalo, New York received over 6.5 feet of snow in late December 2001. In northwestern Lower Peninsula of Michigan snowfall was recorded at over 7.5 feet for December 2001.

Overlake evaporation, however, was significantly reduced in early 2002 as very mild air temperatures prevailed over the region. All told, overlake evaporation for the winter was highly variable from month-to-month being mostly affected by air temperature changes. As a rule, colder air masses covering the region caused higher evaporation.

Evaporation on the Great Lakes for 2001-2002 Meteorological Winter



Ice Cover Implications

When ice forms on the lakes, many aspects of human uses are directly affected and the environment around the region is also modified. Some of the human uses that are affected include the fishing industry, coastal zones, and navigation.

Effects on Fishing

Generally ice cover is a good thing for both commercial and recreational fishing. Ice cover in shallow waters protects the eggs of Great Lakes whitefish from damaging waves and winds. If ice did not form in these areas the survival rate of these eggs would decrease.

Algae are at the bottom of the food chain for all life in the Great Lakes. When clear ice with little or no snow cover on top of it occurs, light penetrates and promotes algal growth in calm, near surface waters.

Effects on Rivers

Ice jams can form when ice flows amass and obstruct how the water normally flows. Jams are most evident in the rivers connecting the Great Lakes (St. Marys, St. Clair, Detroit and Niagara Rivers). Ice buildup can act like a dam and limit the flow from one lake to another. This lack of water downstream can adversely affect hydropower electricity production. Electrical power distributors may have to find alternate sources for power when water flow is limited due to ice buildup. Flooding can also occur upstream of a jam, since less water is allowed to pass.

When jams dissipate, a large quantity of water and ice move downstream and can damage shoreline property. A particularly large ice jam formed on the St. Clair River in April of 1984. This jam is one of the largest and latest occurring on record.

Effects on Coastal Zone

Ice formation along Great Lakes coastlines can be highly beneficial. In a typical winter, ice forms a solid anchor along most shorelines acting as a buffer to wave attack during storms. A solid ice cover on bays and inlets also protects wetland communities from disruptive storm events and associated erosion.

In many cases, ice formation on bays, inlets, major rivers and around islands is essential for several recreational activities, including ice fishing and snowmobiling.

Ice buildup on St. Clair River, 1984 (GLERL)

Effects on Navigation

A hard winter can cause extremely heavy ice buildup along navigation channels in the Great Lakes region. These buildups can cause navigation hazards and disrupt commercial shipping in the early weeks of the winter. Strong ice buildup can also delay the opening of the shipping season.

Since ice cover typically reduces overlake evaporation, a cold winter can moderate losses of water from the lake during low water periods. Higher water levels usually means commercial shipping companies can carry more of their commodity and make fewer trips.

Icebreaking

The United States Coast Guard (USCG) maintains a fleet of icebreaking vessels for the Great Lakes. The Canadian Coast Guard also has polar icebreaking vessels available when needed, being typically more powerful than the American resources.

The USCG Icebreaker Mackinaw has spent 56 years as an icebreaker on the Great Lakes. The vessel is scheduled to be retired to dry-dock in 2005, as a new ship is currently being built which will take over her name and homeport in Cheboygan, Michigan.

The USCG Icebreaker Mackinaw

The USCG Icebreaker Mackinaw was built in 1944 and was the largest and most powerful icebreaker of her time. The ship is a 290-foot vessel and has six engines capable of generating 10,000 horsepower. This horsepower can power through three feet of ice with out stopping. In thicker ice conditions the ship goes into "back and ram" mode, when its engines push the hull atop the ice and crush through it.

The new Mackinaw will be a smaller ship both in size and in crew. The vessel will carry a crew of 50 compared to the 75 that the old Mack carried. The boat will be 240 feet long, have state-of-the-art navigation and propulsion systems and will be capable of breaking 3 feet of ice. The Mack is also suited for other duties including buoy tending. The ship is being built in Manitowac, Wisconsin and is scheduled for delivery in October of 2005.

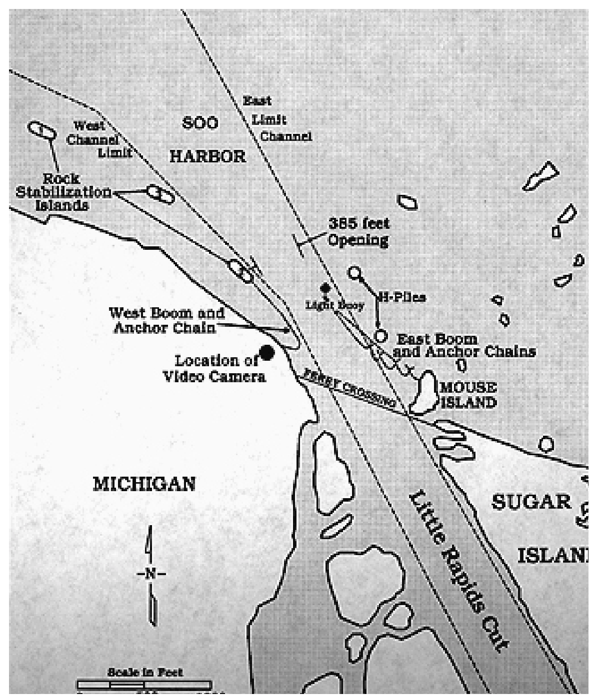
Artist's rendition of the new Mackinaw (Manitowoc Marine Corporation)

During mild winters the USCG averages about 230 hours of ice breaking assistance. This number jumps to 4600 hours during severe ice conditions. During and average winter, the USCG clears the way for about sixty-three million dollars worth of cargo.

St. Marys River Ice Booms

Ice booms are used to limit the flow of ice from the Great Lakes into the connecting rivers. Booms are currently being used to stop ice from moving in the St. Marys River near Soo Harbor, from Lake Erie into the Niagara River, and along the St. Lawrence River.

The booms on the St. Marys were first installed in the early 1980s during a period of investigations about whether the navigation season could be extended year-round on the upper Great Lakes. They were found to be a major benefit to the local economy and provide a safety measure for allowing the Sugar Island Ferry to run continuously. The booms are a series of floating timbers and are located just to the north of the Little Rapids Cut.



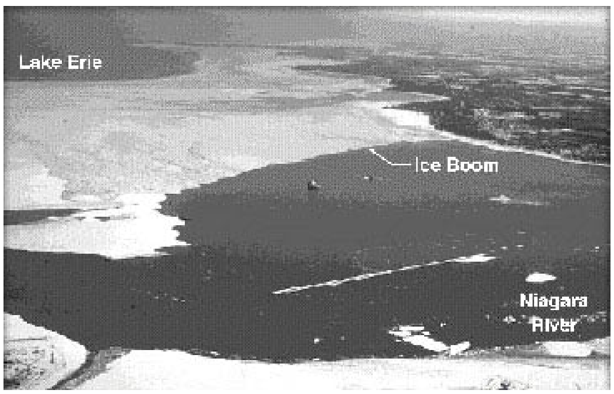
St. Marys River Ice Boom Map

Lake Erie Ice Booms

The ice booms at the mouth of the Niagara River in Lake Erie are placed mainly to protect the power plant intakes on the river from flowing ice. The New York Power Authority and Ontario Power Generation, Limited each operate massive hydro-electric power plants along the river. These power plants provide electricity throughout the region and along the eastern seaboard of the United States.

When ice blocks the water intakes in the Niagara River, power generation is severely limited and the companies must find other means to keep up with the demand for electricity. These means may include running more diesel generators or coal-fired power plants or buying power from other companies.

The Lake Erie ice boom is an 8,800-foot long span made up of floating steel pontoons that are anchored to the lakebed. As you can see from the picture, the boom does a great job in limiting the amount of ice that enters the Niagara River.



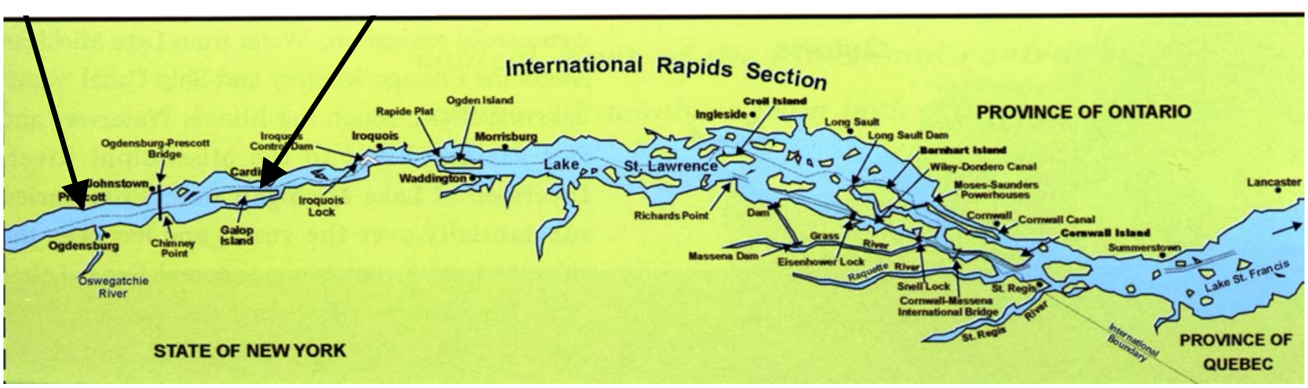
Lake Erie Ice Boom

St. Lawrence River Ice Booms

Ice booms are deployed in a critical reach of the St. Lawrence Seaway. These booms are installed by the hydropower authorities in late fall or early winter to stabilize ice cover upstream of the Moses-Saunders Powerhouse and the associated spillway and lock complex located between Cornwall, Ontario and Massena, New York.

Up to 7 booms are deployed in the river in the general area outlined on the map below. The largest ice boom in this arrangement is nearly 4,400 feet across immediately upstream of Ogdensburg, New York. Going further downstream a smaller boom is deployed upstream of the Ogdensburg – Prescott International Bridge. Four other smaller booms are strategically deployed around Galop Island.

St. Lawrence River Ice Boom Region



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The Iceman Sayeth: Lack of Great Lakes Ice Could Mean a Lot…or Nothing." *Booth Newspapers.* 11 Feb. 2002

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Phone: 905-336-4580
Fax: 905-336-8901
http://www.on.ec.gc.ca/glimr/water-levels/

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http://www.glerl.noaa.gov/

U.S. Coast Guard-District 9
http://www.uscg.mil/d9/uscgd9.html

The New York Power Authority Ice Boom
http://www.iceboom.nypa.gov/

The National Ice Center
http://www.natice.noaa.gov/

International Joint Commission
http://www.ijc.com/

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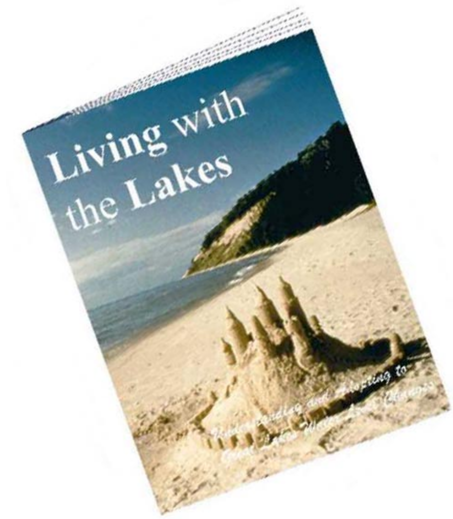

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